Research on quantum information theory, quantum computation, decoherence, quantum chaos, Bose-Einstein condensation, and vacuum fluctuations physics.

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**Mechanism for quantum-classical transition**

\[ \beta \]

Sub-Planck structure in phase space and its relevance for quantum decoherence,

Unconditional pointer states from conditional master equations,

Quantum chaotic environments, the butterfly effect and decoherence,

Decoherence, einselection and the quantum origins of the classical,

**Decoherence**

- Mechanism for quantum-classical transition
  - Interaction between system and environment kills quantum superpositions (Schroedinger cats)
  
  \[ \alpha \text{dec} = \frac{g_0}{1 - \frac{1}{4} g_0} \]

- Decoherence and quantum chaos

- Sub-Planck structure in phase space and its relevance for quantum decoherence,

- Unconditional pointer states from conditional master equations,

- Quantum chaotic environments, the butterfly effect and decoherence,

- Decoherence, einselection and the quantum origins of the classical,
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Quantum information

- Quantum discord as a measure of quantum correlations
  \[ D(S,A)_{\parallel\perp} = I(S : A) - J(S : A)_{\perp\perp} \]
  \[ H(S) + H(A) - H(S,A) = H(S) + H(S|\{P_{jA}\}) \]
- Mutual information (gained about an observable \( I \) on \( S \) in the measurement of an observable \( J \) on \( E \))
- Redundancy of information
- Continuous quantum measurement with multiple observers
  - Quantum discord: a measure of the quantumness of correlations,
  - Quantum discord and Maxwell’s demons,
  - Conditional quantum dynamics with multiple observers,
  - Einselection and decoherence from an information theory perspective,

BEC optics

- Continuous quantum measurement of BECs as a way to control and engineer the quantum state
- Measurement-induced number squeezing
  \[ \sqrt{\frac{N}{S}}(t) = \sqrt{\frac{N}{S}}(0) \]
- Schroedinger cat states in BECs
- Heisenberg-limited interferometry with BECs in optical lattices
  - Measurement-induced squeezing of a Bose-Einstein condensate.,
  - Continuous quantum measurement of a Bose-Einstein condensate: a stochastic GPE equation,
  - Dynamics of a quantum phase transition in an array of Josephson junctions,
  - Decoherence in Bose-Einstein condensates: towards bigger and better Schrödinger cats,

Presenter: Diego Dalvit
Vacuum fluctuations

- Quantum vacuum fluctuations as source for the static and the dynamical Casimir effects

\[ \frac{F}{A} = \frac{\pi^2 \hbar c}{240 L^2} \cdot 0.016 \frac{\text{dyn}}{\text{cm}^2} \]

- Studies of finite conductivity and temperature corrections

- Casimir forces in nanotechnology

- Decoherence via the dynamical Casimir effect,
- Resonant photon creation in a three-dimensional oscillating cavity,
- Quantum electromagnetic field in a three-dimensional oscillating cavity,